CLAIMS

What is claimed is:

1. An adaptive differential pulse code modulation system comprising:

an encoder including:

a subtractor configured for deriving a difference signal E_j, the difference signal E_j being the difference between an input signal Y_j and a predicted signal S_j, j representing a sample period;

a quantizer configured for quantizing the difference signal E_j to obtain a numerical representation N_j for transmission to an encoder inverse quantizer for deriving a regenerated difference signal D_j, and to a decoder inverse quantizer coupled to the quantizer through a network for deriving the regenerated difference signal D_j,

an encoder adder configured for deriving a reconstructed input signal X_j, the reconstructed input signal X_j being the sum of the regenerated difference signal D_j and the predicted signal S_j;

an encoder whitening filter F_e configured for receiving the reconstructed input signal X_j and for generating a filtered reconstructed signal X^f_j, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X_j^f = X_j - a_1^f X_{j-1} - a_2^f X_{j-2} - \ldots . a_n^f X_{j-n}$$

X_{j-n} being a value of reconstructed input signal X_j at sample period *j- n*, and;

n being a number of filter tap coefficients a^f_n corresponding to the whitening filter F_e;

an encoder predictor P_{ep} configured for receiving the reconstructed input signal X_j and for generating a predicted signal S_{jp}, the predicted signal S_{jp} being at least constituent to predicted signal S_j and being generated according to the equation:

$$S_{jp} = a^j_1 S_{j-1} + a^j_2 S_{j-2} \ldots a^j_{np} S_{j-np}$$

S_{j-np} being a value of the predicted signal S_j at sample period $j\text{-}n_p$, and n_p being a number of predictor coefficients a^j_{np} corresponding to the predictor P_{ep}; and

an encoder feedback loop configured for applying the predicted signal S_j to the adder;

transmission means configured for transmitting the numerical representation N_j from the encoder to a decoder; and

the decoder including:

the decoder inverse quantizer coupled to the quantizer through a network and configured for receiving the numerical representation N_j and for deriving the regenerated difference signal D_j therefrom,

a decoder adder configured for deriving the reconstructed input signal X_j, the reconstructed input signal X_j being the sum of the regenerated difference signal D_j and the predicted signal S_j;

a decoder whitening filter F_d configured for receiving the reconstructed input signal X_j and for generating the filtered reconstructed signal X^f_j, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X^f_j = X_j - a^f_1 X_{j-1} - a^f_2 X_{j-2} - \ldots a^f_n X_{j-n}$$

X_{j-n} being a value of reconstructed signal X_j at sample period $j-n$, and

n being the number of filter tap coefficients a^f_n corresponding to the whitening filter F_d;

a decoder predictor P_{dp} configured for receiving the reconstructed input signal X_j and for generating a predicted signal S_{jp}, the predicted signal S_{jp} being at least constituent to predicted signal S_j and being generated according to the equation:

$$S_{jp} = a_1^j S_{j-1} + a_2^j S_{j-2} \ldots a^j_{np} S_{j-np}$$

S_{j-np} being a value of the predicted signal S_j at sample period $j-n_p$, and

n_p being the number of predictor coefficients a^j_{np} corresponding to the predictor P_{dp}; and

a decoder feedback loop configured for applying the predicted signal S_j to the decoder adder.

2. The system of claim 1, further comprising:

a second encoder predictor P_{ez} configured for receiving the regenerated difference signal D_j and for generating a predicted signal S_{jz};

a second encoder adder configured for deriving the predicted signal S_j at the encoder, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz};

a second decoder predictor P_{dz} configured for receiving the regenerated difference signal D_j and for generating a predicted signal S_{jz}; and

a second decoder adder configured for deriving the predicted signal S_j at the decoder, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz}.

3. The system of claim 1 wherein:

n_p is 2;

the predictor coefficient a_1^j is updated according to the equation:

$$a_1^{j+1} = a_1^j(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function; and

the predictor coefficient a_2^j is updated according to the equation:

$$a_2^{j+1} = a_2^j(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^j);$$

δ_2 and g_2 being proper positive constants, and

F_2 being a nonlinear function.

4. The system of claim 1 wherein:

n is 2;

the filter tap coefficient a_1^f is updated at each sample period j according to the generalized equation:

$$a_1^{fj+1} = a_1^{fj}(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function; and

the filter tap coefficients a_2^f is updated at each sample period j according to the generalized equation:

$$a_2^{fj+1} = a_2^{fj}(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^{fj})$$

δ_2 and g_2 being proper positive constants, and

F_2 being a nonlinear function.

5. The system of claim 4 wherein:

the filter tap coefficient a_1^{fj} is updated according to the equation:

$$a_1^{f\,j+1} = a_1^{f\,j}\left(1-\left(\frac{128}{32768}\right)\right) + 192 * \mathrm{sgn}\left[X_j^f\right]\mathrm{sgn}\left[X_{j-1}^f\right]; \text{ and}$$

the filter tap coefficient a_2^{fj} is updated according to the equation:

$$a_2^{f\,j+1} = a_2^{f\,j}\left(1-\left(\frac{256}{32768}\right)\right) - \left(\frac{1}{32}\right)a_1^{f\,j}\,\mathrm{sgn}\left[X_j^f\right]\mathrm{sgn}\left[X_{j-1}^f\right] + 128 * \mathrm{sgn}\left[X_j^f\right]\mathrm{sgn}\left[X_{j-2}^f\right];$$

sgn[ ] being a sign function that returns a value of 1 for a nonnegative argument and a value of -1 for a negative argument.

6. The system of claim 5 wherein at every other sample period j,

the filter tap coefficient a^{fj+1}_2 is maintained in a range $-12288 \leq a^{fj+1}_2 \leq 12288$; and

the filter tap coefficient a^{fj+1}_1 is maintained in a range $-(15360 - a^{fj+1}_2) \leq a^{fj+1}_1 \leq (15360 - a^{fj+1}_2)$;

whereby a^{fj+1}_1 is set equal to $(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 > 15360 - a^{fj+1}_2$; and

whereby a^{fj+1}_1 is set equal to $-(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 < -(15360 - a^{fj+1}_2)$.

7. The system of claim 5, further comprising:

a second encoder predictor P_{ez} configured for receiving the regenerated difference signal D_j and for generating a predicted signal S_{jz};

a second encoder adder configured for deriving the predicted signal S_j at the encoder, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz};

a second decoder predictor P_{dz} configured for receiving the regenerated difference signal D_j and for generating a predicted signal S_{jz}; and

a second decoder adder configured for deriving the predicted signal S_j at the decoder, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz}.

8. The system of claim 1 wherein at every other sample period j, the predictor coefficient a^j_{np} corresponding to the predictors P_{ep} and P_{dp} is maintained unchanged.

9. The system of claim 8, such that if for even j:

$$a_1^{j+1} = a_1^j, \text{ and}$$

$$a_2^{j+1} = a_2^j,$$

then for odd j:

$$a_1^{j+1} = a_1^{j-1}\left(1-\left(\frac{127.5}{32768}\right)\right) + 191.25 * \operatorname{sgn}\left[X^f_{j-1}\right]\operatorname{sgn}\left[X^f_{j-2}\right] + 192 * \operatorname{sgn}\left[X^f_j\right]\operatorname{sgn}\left[X^f_{j-1}\right], \text{ and}$$

$$a_2^{j+1} = a_2^{j-1}\left(1-\left(\frac{510}{32768}\right)\right) - \left(\frac{1016}{32768}\right)\lim\left[a_1^{j-1}\right]\operatorname{sgn}\left[X^f_{j-1}\right]\operatorname{sgn}\left[X^f_{j-2}\right] + 127 * \operatorname{sgn}\left[X^f_{j-1}\right]\operatorname{sgn}\left[X^f_{j-3}\right]$$
$$-\left(\frac{1}{32}\right)\lim\left[a_1^{j-1}\right]\operatorname{sgn}\left[X^f_j\right]\operatorname{sgn}\left[X^f_{j-1}\right] + 128 * \operatorname{sgn}\left[X^f_j\right]\operatorname{sgn}\left[X^f_{j-2}\right],$$

sgn[ ] being a sign function that returns a value of 1 for a nonnegative argument and a value of -1 for a negative argument, and

$\lim\left[a_1^{j-1}\right] = a_1^{j-1}$ for $-8192 \le a_1^{j-1} \le 8191$,

$\lim\left[a_1^{j-1}\right] = -8192$ for $a_1^{j-1} < -8191$, and

$\lim\left[a_1^{j-1}\right] = 8192$ for $a_1^{j-1} > 8191$.

10. An encoder for encoding digital audio signals, comprising:

a subtractor configured for deriving a difference signal E_j, the difference signal E_j being the difference between an input signal Y_j and a predicted signal S_j, j representing a sample period;

a quantizer configured for quantizing the difference signal E_j to obtain a numerical representation N_j for transmission to an encoder inverse quantizer for deriving a regenerated difference signal D_j, and to a decoder inverse quantizer coupled to the quantizer for deriving the regenerated difference signal D_j;

an adder configured for deriving a reconstructed input signal X_j, the reconstructed input signal X_j being the sum of the regenerated difference signal D_j and the predicted signal S_j;

a whitening filter configured for receiving the reconstructed input signal X_j and for generating a filtered reconstructed signal X^f_j, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X^f_j = X_j - a^f_1 X_{j-1} - a^f_2 X_{j-2} - \ldots a^f_n X^f_{j-n}$$

X^f_{j-n} being a value of filtered reconstructed signal X^f_j at sample period *j- n*, and

n being a number of filter tap coefficients a^f_n corresponding to the whitening filter;

a predictor configured for receiving the reconstructed input signal X_j and for generating a predicted signal S_{jp}, the predicted signal S_{jp} being at least

constituent to predicted signal S_j and being generated according to the equation:

$$S_{jp} = a^j_1 S_{j-1} - a^j_2 S_{j-2} - \ldots a^j_{np} S_{j-np}$$

S_{j-np} being a value of the predicted signal S_j at sample period $j-n_p$, and

n_p being a number of predictor coefficients a^j_{np} corresponding to the predictor; and

a feedback loop configured for applying the predicted signal S_j to the adder.

11. The system of claim 10, the encoder further comprising:

a second predictor configured for receiving the regenerated difference signal D_j and for generating a predicted signal S_{jz}, the predicted signal S_{jz} being at least constituent to predicted signal S_j; and

a second adder configured for deriving the predicted signal S_j, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz}.

12. The system of claim 10 wherein:

n is 2;

the filter tap coefficient a_i^f is updated at each sample period j according to the generalized equation:

$$a_1^{fj+1} = a_1^{fj}(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function;

the filter tap coefficients a_2^f is updated at each sample period j according to the generalized equation:

$$a_2^{fj+1} = a_2^{fj}(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^{fj})$$

δ_2 and g_2 being proper positive constants, and

F_2 being a nonlinear function.

13. The system of claim 12 wherein:

the filter tap coefficient a_1^f is updated according to the equation:

$$a_1^{f\,j+1} = a_1^{f\,j}\left(1-\left(\frac{128}{32768}\right)\right) + 192 * \operatorname{sgn}\left[X_j^f\right]\operatorname{sgn}\left[X_{j-1}^f\right] \text{ and}$$

the filter tap coefficient a_2^f is updated according to the equation:

$$a_2^{f\,j+1} = a_2^{f\,j}\left(1-\left(\frac{256}{32768}\right)\right) - \left(\frac{1}{32}\right)a_1^{f\,j}\operatorname{sgn}\left[X_j^f\right]\operatorname{sgn}\left[X_{j-1}^f\right] + 128 * \operatorname{sgn}\left[X_j^f\right]\operatorname{sgn}\left[X_{j-2}^f\right],$$

sgn[ ] being a sign function that returns a value of 1 for a nonnegative argument and a value of –1 for a negative argument.

14. The system of claim 13 wherein at every other sample period *j*,

the filter tap coefficient a^{fj+1}_2 is maintained in a range $-12288 \leq a^{fj+1}_2 \leq 12288$; and

the filter tap coefficient a^{fj+1}_1 is maintained in a range $-(15360 - a^{fj+1}_2) \leq a^{fj+1}_1 \leq (15360 - a^{fj+1}_2)$;

whereby a^{fj+1}_1 is set equal to $(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 > 15360 - a^{fj+1}_2$; and

whereby a^{fj+1}_1 is set equal to $-(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 < -(15360 - a^{fj+1}_2)$.

15. The system of claim 10 wherein at every other sample period *j*, the predictor coefficient a^j_{np} corresponding to the predictor is maintained unchanged.

16. The system of claim 10, wherein the encoder is constituent to or coupled to a videoconferencing device or application.

17. A decoder for decoding digital audio signals encoded by a properly associated encoder, comprising:

an inverse quantizer coupled to the encoder and configured for receiving a numerical representation N_j and for deriving a regenerated difference signal D_j therefrom, the numerical representation N_j being a quantized representation of a difference signal E_j, the difference signal E_j being the difference between an input signal Y_j and a predicted signal S_j, j representing a sample period;

an adder configured for deriving a reconstructed input signal X_j, the reconstructed input signal X_j being the sum of the regenerated difference signal D_j and the predicted signal S_j;

a whitening filter configured for receiving the reconstructed input signal X_j and for generating a filtered reconstructed signal X^f_j, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X^f_j = X_j - a^f_1 X_{j-1} - a^f_2 X_{j-2} - \ldots a^f_n X^f_{j-n}$$

X^f_{j-n} being a value of filtered reconstructed signal X^f_j at sample period $j-n$, and

n being a number of filter tap coefficients a^f_n corresponding to the whitening filter;

a predictor configured for receiving the reconstructed input signal X_j and for generating a predicted signal S_{jp}, the predicted signal S_{jp} being at least

constituent to predicted signal S_j and being generated according to the equation:

$$S_{jp} = a^j_1 S_{j-1} - a^j_2 S_{j-2} - \ldots a^j_{np} S_{j-np}$$

S_{j-np} being a value of the predicted signal S_j at sample period $j-n_p$, and

n_p being a number of predictor coefficients a^j_{np} corresponding to the predictor; and

a feedback loop configured for applying the predicted signal S_j to the adder.

18. The system of claim 17, the decoder further comprising:

a second predictor configured for receiving the regenerated difference signal D_j and for generating a predicted signal S_{jz}, the predicted signal S_{jz} being at least constituent to predicted signal S_j; and

a second adder configured for deriving the predicted signal S_j, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz}.

19. The system of claim 17 wherein:

n is 2;

the filter tap coefficient a_1^f is updated at each sample period j according to the generalized equation:

$$a_1^{fj+1} = a_1^{fj}(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function;

the filter tap coefficients a_2^f is updated at each sample period j according to the generalized equation:

$$a_2^{fj+1} = a_2^{fj}(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^{fj})$$

δ_2 and g_2 being proper positive constants, and;

F_2 being a nonlinear function.

20. The system of claim 19 wherein:

the filter tap coefficient a_1^f is updated according to the equation:

$$a_1^{f\,j+1} = a_1^{f\,j}\left(1-\left(\frac{128}{32768}\right)\right) + 192 * \operatorname{sgn}\left[X_j^f\right]\operatorname{sgn}\left[X_{j-1}^f\right] \text{ and}$$

the filter tap coefficient a_2^f is updated according to the equation:

$$a_2^{f\,j+1} = a_2^{f\,j}\left(1-\left(\frac{256}{32768}\right)\right) - \left(\frac{1}{32}\right)a_1^{f\,j}\operatorname{sgn}\left[X_j^f\right]\operatorname{sgn}\left[X_{j-1}^f\right] + 128 * \operatorname{sgn}\left[X_j^f\right]\operatorname{sgn}\left[X_{j-2}^f\right]$$

sgn[ ] being a sign function that returns a value of 1 for a nonnegative argument and a value of –1 for a negative argument.

21. The system of claim 20 wherein at every other sample period *j*,

the filter tap coefficient a^{fj+1}_2 is maintained in a range $-12288 \le a^{fj+1}_2 \le 12288$; and

the filter tap coefficient a^{fj+1}_1 is maintained in a range $-(15360 - a^{fj+1}_2) \leq a^{fj+1}_1 \leq (15360 - a^{fj+1}_2)$;

whereby a^{fj+1}_1 is set equal to $(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 > 15360 - a^{fj+1}_2$; and

whereby a^{fj+1}_1 is set equal to $-(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 < -(15360 - a^{fj+1}_2)$.

22. The system of claim 17 wherein at every other sample period *j*, the predictor coefficient a^{j}_{np} corresponding to the predictor is maintained unchanged.

23. The system of claim 17, wherein the decoder is constituent to or coupled to a videoconferencing device or application.

24. A method for encoding and decoding digital audio signals, comprising the steps of:

deriving a difference signal E_j at an encoder, the difference signal E_j being the difference between an input signal Y_j and a predicted signal S_j, j representing a sample period;

quantizing the difference signal E_j to obtain a numerical representation N_j for transmitting to an encoder inverse quantizer for deriving a regenerated difference signal D_j, and to a decoder inverse quantizer coupled to the quantizer through a network for deriving the regenerated difference signal D_j;

deriving a reconstructed input signal X_j at a first adder, the reconstructed input signal X_j being the sum of the regenerated difference signal D_j and the predicted signal S_j;

receiving the reconstructed input signal X_j at a whitening filter F_e;

generating a filtered reconstructed signal X^f_j by the whitening filter F_e, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X^f_j = X_j - a^f_1 X_{j-1} - a^f_2 X_{j-2} - \ldots a^f_n X^f_{j-n}$$

X^f_{j-n} being a value of filtered reconstructed signal X^f_j at sample period $j-n$, and

n being a number of filter tap coefficients a^f_n corresponding to the whitening filter F_e;

receiving the reconstructed input signal X_j at a predictor P_{ep};

generating a predicted signal S_{jp} by the predictor P_{ep},the predicted signal S_{jp} being at least constituent to predicted signal S_j and being generated according to the equation:

$$S_{jp} = a^j{}_1 S_{j-1} - a^j{}_2 S_{j-2} - \ldots a^j{}_{np} S_{j-np}$$

S_{j-np} being a value of the predicted signal S_j at sample period $j\text{-}n_p$, and n_p being a number of predictor coefficients $a^j{}_{np}$ corresponding to the predictor P_{ep};

applying the predicted signal S_j to the first adder to provide feedback;

receiving the numerical representation N_j at a decoder;

deriving the regenerated difference signal D_j from the numerical representation N_j,

deriving the reconstructed input signal X_j at a second adder, the reconstructed input signal X_j being the sum of the regenerated difference signal D_j and the predicted signal S_j;

receiving the reconstructed input signal X_j at a whitening filter F_d;

generating a filtered reconstructed signal $X^f{}_j$ by the whitening filter F_d, the filtered reconstructed signal $X^f{}_j$ being generated according to the equation:

$$X^f{}_j = X_j - a^f{}_1 X_{j-1} - a^f{}_2 X_{j-2} - \ldots a^f{}_n X^f{}_{j-n}$$

$X^f{}_{j-n}$ being a value of filtered reconstructed signal $X^f{}_j$ at sample period $j\text{-}\ n$; n being a number of filter tap coefficients $a^f{}_n$ corresponding to the whitening filter F_d;

receiving the reconstructed input signal X_j at a predictor P_{dp};

generating a predicted signal S_{jp} by the predictor P_{dp}, the predicted signal S_{jp} being at least constituent to predicted signal S_j and being generated according to the equation:

$$S_{jp} = a^j_1 S_{j-1} - a^j_2 S_{j-2} - \ldots a^j_{np} S_{j-np}$$

S_{j-np} being a value of the predicted signal S_j at sample period $j-n_p$, and n_p being a number of predictor coefficients a^j_{np} corresponding to the predictor P_{dp}; and

applying the predicted signal S_j to the second adder to provide feedback.

25. The method of claim 24, further comprising the steps of:

receiving the regenerated difference signal D_j at a predictor P_{ez} at the encoder;

generating a predicted signal S_{jz} by the predictor P_{ez};

deriving the predicted signal S_j at the encoder, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz};

receiving the regenerated difference signal D_j at a predictor P_{dz} at the decoder;

generating the predicted signal S_{jz} by the predictor P_{dz}; and

deriving the predicted signal S_j at the decoder, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz}.

26. The method of claim 24 wherein n_p is 2, further comprising the steps of:

updating the predictor coefficient a_1^j according to the equation:

$$a_1^{j+1} = a_1^j(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function; and

updating the predictor coefficient a_2^j according to the equation:

$$a_2^{j+1} = a_2^j(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^j)$$

δ_2 and g_2 being proper positive constants, and;

F_2 being a nonlinear function.

27. The method of claim 24 wherein *n* is 2, further comprising the steps of:

updating the filter tap coefficient a_1^f at each sample period j according to the generalized equation:

$$a_1^{fj+1} = a_1^{fj}(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function; and

updating the filter tap coefficients a_2^f at each sample period j according to the generalized equation:

$$a_2^{fj+1} = a_2^{fj}(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^{fj})$$

δ_2 and g_2 being proper positive constants, and

F_2 being a nonlinear function.

28. The method of claim 27 wherein:

the filter tap coefficient a_1^f is updated according to the equation:

$$a_1^{f\,j+1} = a_1^{f\,j}\left(1-\left(\frac{128}{32768}\right)\right)+192*\mathrm{sgn}[X_j^f]\mathrm{sgn}[X_{j-1}^f], \text{ and}$$

the filter tap coefficient a_2^f is updated according to the equation:

$$a_2^{f\,j+1} = a_2^{f\,j}\left(1-\left(\frac{256}{32768}\right)\right)-\left(\frac{1}{32}\right)a_1^{f\,j}\,\mathrm{sgn}[X_j^f]\mathrm{sgn}[X_{j-1}^f]+128*\mathrm{sgn}[X_j^f]\mathrm{sgn}[X_{j-2}^f]$$

sgn[ ] being a sign function that returns a value of 1 for a nonnegative argument and a value of –1 for a negative argument.

29. The method of claim 28 wherein at every other sample period *j*,

the filter tap coefficient a^{fj+1}_2 is maintained in a range $-12288 \le a^{fj+1}_2 \le 12288$; and

the filter tap coefficient a^{fj+1}_1 is maintained in a range $-(15360 - a^{fj+1}_2) \le a^{fj+1}_1 \le (15360 - a^{fj+1}_2)$;

whereby a^{fj+1}_1 is set equal to $(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 > 15360 - a^{fj+1}_2$; and

whereby a^{fj+1}_1 is set equal to $-(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 < -(15360 - a^{fj+1}_2)$.

30. The method of claim 28, further comprising the steps of:

receiving the regenerated difference signal D_j at a predictor P_{ez} at the encoder;

generating a predicted signal S_{jz} by the predictor P_{dz};

deriving the predicted signal S_j at the encoder, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz};

receiving the regenerated difference signal D_j at a predictor P_{dz} at the decoder;

generating the predicted signal S_{jz} by the predictor P_{dz}; and

deriving the predicted signal S_j at the decoder, the predicted signal S_j being the sum of the predicted signal S_{jp} and the predicted signal S_{jz}.

31. The method of claim 28 wherein n_p is 2, further comprising the steps of:

updating the predictor coefficient a_1^j according to the equation:

$$a_1^{j+1} = a_1^j(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function; and

updating the predictor coefficient a_2^j according to the equation:

$$a_2^{j+1} = a_2^j(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^j)$$

δ_2 and g_2 being proper positive constants, and;

F_2 being a nonlinear function.

32. A method for adapting coefficients in a two pole predictor in an adaptive differential pulse code modulation system, comprising the steps of:

generating a filtered reconstructed signal X^f_j by a whitening filter F_e, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X^f_j = X_j - a^f_1 X_{j-1} - a^f_2 X_{j-2} - \dots a^f_n X^f_{j-n}$$

X^f_{j-n} being a value of filtered reconstructed signal X^f_j at sample period *j- n*,

and

n being a number of filter tap coefficients a^f_n corresponding to the whitening filter F_e;

updating a predictor coefficient a^j_1 according to the equation:

$$a^{j+1}_1 = a^j_1(1-\delta_1) + g_1 \cdot F_1(X^f_j, X^f_{j-1}, X^f_{j-2})$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function; and

updating a predictor coefficient a^j_2 according to the equation:

$$a^{j+1}_2 = a^j_2(1-\delta_2) + g_2 \cdot F_2(X^f_j, X^f_{j-1}, X^f_{j-2}, a^j_1)$$

δ_2 and g_2 being proper positive constants, and

F_2 being a nonlinear function.

33. The method of claim 32, further comprising the steps of:

updating the filter tap coefficient a^f_1 at each sample period *j* according to the generalized equation:

$$a_1^{fj+1} = a_1^{fj}(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function; and

updating the filter tap coefficients a_2^f at each sample period j according to the generalized equation:

$$a_2^{fj+1} = a_2^{fj}(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^{fj})$$

δ_2 and g_2 being proper positive constants, and

F_2 being a nonlinear function.

34. The method of claim 32 wherein:

the filter tap coefficient a_1^f is updated according to the equation:

$$a_1^{f\,j+1} = a_1^{f\,j}\left(1-\left(\frac{128}{32768}\right)\right) + 192 * \mathrm{sgn}\left[X_j^f\right]\mathrm{sgn}\left[X_{j-1}^f\right] \text{ and}$$

the filter tap coefficient a_2^f is updated according to the equation:

$$a_2^{f\,j+1} = a_2^{f\,j}\left(1-\left(\frac{256}{32768}\right)\right) - \left(\frac{1}{32}\right)a_1^{f\,j}\,\mathrm{sgn}\left[X_j^f\right]\mathrm{sgn}\left[X_{j-1}^f\right] + 128 * \mathrm{sgn}\left[X_j^f\right]\mathrm{sgn}\left[X_{j-2}^f\right]$$

sgn[ ] being a sign function that returns a value of 1 for a nonnegative argument and a value of –1 for a negative argument.

35. The method of claim 34 wherein at every other sample period *j*,

the filter tap coefficient a^{fj+1}_2 is maintained in a range $-12288 \le a^{fj+1}_2 \le 12288$; and

the filter tap coefficient a^{fj+1}_1 is maintained in a range $-(15360 - a^{fj+1}_2) \leq a^{fj+1}_1 \leq (15360 - a^{fj+1}_2)$;

whereby a^{fj+1}_1 is set equal to $(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 > 15360 - a^{fj+1}_2$; and

whereby a^{fj+1}_1 is set equal to $-(15360 - a^{fj+1}_2)$ when $a^{fj+1}_1 < -(15360 - a^{fj+1}_2)$.

36. A machine readable medium embodying instructions executable by a machine to perform a method for adapting coefficients in a two pole predictor in an adaptive differential pulse code modulation system, the method steps comprising:

generating a filtered reconstructed signal X^f_j by a whitening filter, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X^f_j = X_j - a^f_1 X_{j-1} - a^f_2 X_{j-2} - \ldots a^f_n X^f_{j-n}$$

X^f_{j-n} being a value of filtered reconstructed signal X^f_j at sample period $j-n$, and

n being a number of filter tap coefficients a^f_n corresponding to the whitening filter;

updating a predictor coefficient a_1^j according to the equation:

$$a_1^{j+1} = a_1^j(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function; and

updating a predictor coefficient a_2^j according to the equation:

$$a_2^{j+1} = a_2^j(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^j)$$

δ_2 and g_2 being proper positive constants, and

F_2 being a nonlinear function.

37. A digital circuit embodying instructions to perform a method for adapting coefficients in a two pole predictor in an adaptive differential pulse code modulation system, the method steps comprising:

generating a filtered reconstructed signal X^f_j by a whitening filter, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X^f_j = X_j - a^f_1 X_{j-1} - a^f_2 X_{j-2} - \ldots a^f_n X^f_{j-n}$$

X^f_{j-n} being a value of filtered reconstructed signal X^f_j at sample period $j- n$,

and

n being a number of filter tap coefficients a^f_n corresponding to the whitening filter;

updating a predictor coefficient a_1^j according to the equation:

$$a_1^{j+1} = a_1^j(1-\delta_1) + g_1 \cdot F_1(X_j^f, X_{j-1}^f, X_{j-2}^f)$$

δ_1 and g_1 being proper positive constants, and

F_1 being a nonlinear function; and

updating a predictor coefficient a_2^j according to the equation:

$$a_2^{j+1} = a_2^j(1-\delta_2) + g_2 \cdot F_2(X_j^f, X_{j-1}^f, X_{j-2}^f, a_1^j)$$

δ_2 and g_2 being proper positive constants, and

F_2 being a nonlinear function.

38. An adaptive differential pulse code modulation system comprising:

at a first instance:

means for deriving a difference signal E_j, the difference signal E_j being the difference between an input signal Y_j and a predicted signal S_j, j representing a sample period;

means for quantizing the difference signal E_j to obtain a numerical representation N_j;

means for deriving a regenerated difference signal D_j based on the numerical representation N_j,

means for transmitting the numerical representation N_j to an inverse quantizing means coupled to the quantizing means through a network;

means for deriving a reconstructed input signal X_j, the reconstructed input signal X_j being the sum of the regenerated difference signal D_j and the predicted signal S_j;

means for generating a filtered reconstructed signal X^f_j, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X^f_j = X_j - a^f_1 X_{j-1} - a^f_2 X_{j-2} - \ldots a^f_n X^f_{j-n}$$

X^f_{j-n} being a value of filtered reconstructed signal X^f_j at sample period $j- n$,

and

n being a number of coefficients a^f_n corresponding to the means for generating a filtered reconstructed signal;

means for generating a predicted signal S_{jp}, the predicted signal S_{jp} being at least constituent to predicted signal S_j and being generated according to the equation:

$$S_{jp} = a^j_1 S_{j-1} - a^j_2 S_{j-2} - \ldots a^j_{np} S_{j-np}$$

S_{j-np} being a value of the predicted signal S_j at sample period j-n_p, and

n_p being a number of predictor coefficients a^j_{np} corresponding to the means for generating a predicted signal; and

feedback means for applying the predicted signal S_j to the means for deriving a reconstructed input signal X_j;

at a second instance:

the inverse quantizing means for deriving the regenerated difference signal D_j from the numerical representation N_j;

second means for deriving a reconstructed input signal X_j, the reconstructed input signal X_j being the sum of the regenerated difference signal D_j and the predicted signal S_j;

second means for generating a filtered reconstructed signal X^f_j, the filtered reconstructed signal X^f_j being generated according to the equation:

$$X^f_j = X_j - a^f_1 X_{j-1} - a^f_2 X_{j-2} - \ldots a^f_n X^f_{j-n}$$

X^f_{j-n} being a value of filtered reconstructed signal X^f_j at sample period j- n, and

n being a number of coefficients a^f_n corresponding to the second means for generating a filtered reconstructed signal;

second means for generating a predicted signal S_{jp}, the predicted signal S_{jp} being at least constituent to predicted signal S_j and being generated according to the equation:

$$S_{jp} = a^j_1 S_{j-1} - a^j_2 S_{j-2} - \ldots a^j_{np} S_{j-np}$$

S_{j-np} being a value of the predicted signal S_j at sample period $j-n_p$, and

n_p being a number of coefficients a^j_{np} corresponding to the means for generating a predicted signal; and

feedback means for applying the predicted signal S_j to the means for deriving a reconstructed input signal X_j.